

DEPARTAMENTO DE FÍSICA DE LA MATERIA CONDENSADA

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REVIEW OF PhD THESIS REPORT

By foreign supervisor, Professor Ramos, Miguel-Angel, Doctor of Physical Sciences,
Department of Condensed Matter Physics at Universidad Autónoma de Madrid, Spain

on the thesis presented by *Nurmukan, Assel Yerzhumaevna* entitled

« *Relaxation processes in thin films of freon cryovacuum condensates* »

submitted to obtain the degree of Doctor of Philosophy, PhD, in the doctoral program
"6D071000 – Materials Science and Technology of New Materials"

The PhD thesis of Assel Nurmukan has been devoted to the study of cryovacuum condensates of different organic substances, especially of freons such as tetrafluoroethane (known as Freon 134a), as well as of tetrachloromethane films.

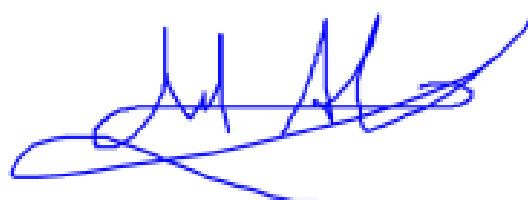
The main experimental technique mastered in the PhD candidate's laboratory is that of cryovacuum condensation (typically at 16 K), which allows the preparation of thin films in amorphous and plastic-crystal disordered phases at low temperatures from the gas phase. The obtained films are akin to the glasses prepared by directly supercooling the liquid phase through the glass transition, but also may exhibit some interesting differences. Once the samples have been grown at low temperature, their temperature is gradually increased, so that distinct relaxation processes and structural transformations can be monitored by means of *in situ* infrared (IR) spectroscopic studies. In particular, the study of the vibrational spectra and the evolution of the refractive index as a function of temperature allow to identify the different structural transformations observed in the studied materials, including glass-transition phenomena and partially disordered crystalline phases.

Furthermore, the study of this polymorphism in condensed-matter phases formed at low temperatures under high vacuum, and the optical characterization of these cryocondensates, are also relevant for the development of cryogenics and its modern applications, such as special and rocket technology, cryobiology and cryomedicine, cryoelectronics, etc.

The results obtained in the PhD thesis realized by Assel Nurmukan can be considered as original and fruitful, providing a wide set of exhaustive spectrometric studies as a function of temperature for the different substances studied. These results have been presented at international scientific meetings or conferences, and especially they have been published in international scientific journals of a good level. It is to be stressed that in the highest-level published articles the PhD candidate appears as the only corresponding author of the paper.

I can add that Assel Nurmukan performed a scientific stay in my laboratory within her doctoral program. She showed a good scientific attitude and was able to learn and participate in related experimental work at low temperatures, what was useful for her doctoral formation.

In summary, it can be concluded that Assel Nurmukan's Doctoral Thesis entitled *Relaxation processes in thin films of freon cryovacuum condensates* has a high-enough scientific level as to be defended, so that the candidate can obtain her doctoral degree.



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